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COTTON SELECTION ON THE FARM BY THE CHARACTERS OF THE STALKS, LEAVES, AND BOLLS.

BY

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COTTON SELECTION ON THE FARM BY THE CHARACTERS OF THE STALKS, LEAVES, AND BOLLS.

INTRODUCTION.

The plan of growing in a separate field the cotton that is to be used for seed has several advantages, but one of the most important is often overlooked. It is the education of the farmer himself, so that he can know his variety by its external characters even in the earlier stages of growth. The result of many experiments in the acclimatization and breeding of cotton shows that the work of selection can be made much easier and more effective by giving attention to the external characters of the plants in the field instead of waiting till the crop is ripe and depending on the seed and lint characters alone.

The advantages that have been urged for the separate seed plat are the keeping of the select stock from crossing with the general field planting, the giving of better conditions and care, the better opportunity of individual selection by having the best plants together instead of scattered in the general field, and the easier avoidance of admixture of seed in the fall by the separate picking and ginning of the cotton from the seed plat. Each of these considerations is of distinct practical importance, but the seed plat has one more possibility that may bring us still nearer to the desired result of better and more uniform crops of cotton. Every farmer who is intelligent and careful enough to maintain a separate seed plat should be able to see the importance of going one step farther and making full use of the opportunity for improvement with which he is already provided.

It is possible to apply to the cotton crop the same methods of roguing that are used to maintain the uniformity of high-grade varieties of garden plants. A cabbage or a beet that shows itself inferior or that departs from the characters of its variety is not kept to grow seed, or even allowed to open its blossoms in the same field with the plants that remain "true to type." The fact that the lint of the cotton seed is the part used, instead of the leaves or the roots, easily explains why so much attention has been given to the characters of the seed and so little to those of other parts of the plant. In reality the habits of growth and other external characters not only have direct agricultural importance in themselves, but they have also an indirect value in making it possible to recognize and rogue out undesirable variations. The work of selection need not be deferred till the seed is ripe, but can begin even before the flowers have opened and allowed the good plants to be crossed with the pollen of degenerate variations.

THE IMPORTANCE OF UNIFORMITY.

It is not sufficient to make a seed plat and to plant in it only the seed of good plants. The plants that grow in the seed plat must all be alike if the largest and most uniform crop is to be secured. Uniformity has a direct commercial value in cotton. To grow fiber of good quality but mixed with short, weak fiber is of little or no advantage to the farmer. If the manufacturer can buy the long fiber at the same price as the short, he can afford to spin it and let the machinery sort the short fiber out, but if he is to pay higher prices for long fiber he naturally objects to having it mixed with short. No farmer who hopes to command a premium for raising superior cotton can afford to neglect uniformity. If the staple were uniform the manufacturers would be willing to pay premiums for the cotton of many districts that now obtain only the general market prices of the ordinary short-staple grades.

The fact that the uniformity and other characters of the lint receive so little consideration in the marketing of Upland cotton has allowed people to overlook the damage that is being done to the industry by the failure to select and by the mixing of varieties in the field and at the gin. Some are inclined to lay all the responsibility on the gin, on the ground that farmers are kept from selecting their own seed in the field because of the probability that their seed would only be mixed up again at the gin.

This amounts to a very serious charge, for if the gin system is really responsible for the general failure to apply selection in the whole Upland cotton industry, it causes an annual loss of many millions of dollars. Experiments indicate that the failure to select the seed commonly diminishes the crop from 10 to 20 per cent below the yield that might otherwise be obtained from the same land and with the same cultivation. The deficiency of quality involved in the production of short, weak, and irregular staple probably involves an even greater loss than the diminished yield. A hundred million dollars per annum would not cover the total loss, which may be more than twice that amount. The boll weevil is not the only difficult problem of cotton culture. The losses threatened by the weevil can be made good to a very large extent by better attention to other factors that influence the crop.

It would be very difficult to imagine a condition more likely to discourage any effort toward the improvement of the crop than the system of large public gins that require a continuous charge of cotton for the machinery to work. Under ordinary conditions of ginning every farmer is likely to get his seed well mixed with the seed of some other farmer, and may have a sprinkling from the whole neighborhood. On account of the mechanical advantages of the large modern ginning establishments and the large amounts of capital invested in the present equipments, any complete or sudden change seems entirely out of the question.

It is possible to avoid much of the difficulty in a way that is not very expensive and would save every year many times what it would cost. Small separate gins are being installed in some localities for ginning the cotton that is to furnish seed for planting. The same power can be used and the lint can be baled with that from the large gins, but the seed can be kept entirely separate. As soon as farmers realize the importance of keeping their seed separate, ginners will find it to their advantage to install the separate small gins in order to attract the custom of the more intelligent farmers who select their own seed. It is also to be expected that many public-spirited owners of ginning establishments will provide separate gins to encourage the farmers along the line of seed selection. Doubtless the time will come when all public gins will be equipped to handle separate stocks of seed without mixing, as a result of a general recognition of the value of such precautions to the whole cotton-growing community.

RESULTS OF MIXING VARIETIES.

Apart from the question of higher prices for longer or more uniform staples, there is a relation between uniformity and yield. The farmer might naturally suppose that the selection of seed from the most fertile plants would insure the largest possible yields, even if the plants are not all of exactly the same type or strain. Yet there are scientific facts which show that the mixing of varieties can eventually affect the yield of fiber, as well as the quality. The plants of a mixed stock are quite as likely to differ in earliness and productiveness as in the length and strength of the fiber. The same factors that render a mixture of varieties deficient in uniformity of fiber also tend to decrease the yield.

The bad effects of mixing varieties are not generally appreciated because the results are not likely to appear at first. If two equally productive varieties were really pure and uniform to begin with, the yield would not diminish in the first year simply because they were grown in a mixed field instead of being planted in separate fields. In the next year the yield might still be unaffected, or might even be somewhat increased, if the greater vigor of the first generation of hybrid plants rendered them more productive. But it often happens that the more vigorous plants are not more productive, because they begin by putting out too many vegetative limbs instead of fruiting branches. The crop is not set so early and is more likely to be destroyed by the boll weevils. The admixture of the varieties by cross-pollination might show no bad results until the second year after the seed is mixed and plants of different kinds are cross-fertilized.

If the effects of the crossing of varieties were limited to the production of vigorous intermediate hybrids, like those of the first generation, the yield might never be seriously affected. In the second and later generations of hybrids another factor comes into play, the factor of increased diversity that results from the crossing of different types of cotton. Even when the first generation of hybrids is closely similar to one of the parents or merely intermediate between the parents, the second and later generations are usually much more diverse. In addition to many different degrees and combinations between the characters of the original parents that were crossed, many other characters quite outside of those of the selected parent varieties are likely to appear.

To permit indiscriminate crossing among the second and later generations of hybrid plants is the way to undo the work of selection and return toward the original condition of indiscriminate diversity found in unselected stocks. The result of indiscriminate crossing seems to be that the characters of inferior ancestors are brought back into expression and may completely submerge the characters of the specially selected superior ancestors. In a series of experiments that has been made with hybrids between the Egyptian and Upland types of cotton the first generation hybrids had longer and better lint than either of the parent types. The later generations not only failed to maintain the promise of the first generation, but gradually receded. The fourth and fifth generations failed to show any plants with lint equal to the Egyptian parent, and very few were equal to the Upland. No matter how superior the varieties may be at the beginning, indiscriminate mixing can only be expected to lead back to inferior mongrels, or "scrubs," the same kinds of inferior plants that can be found in every field of ordinary unselected cotton.

DIVERSITY IN UNSELECTED FIELDS OF COTTON.

In a neglected stock of cotton that has not been receiving any selection at all the plants are not all equally inferior, but each individual plant is likely to be different from any of its neighbors. The differences between the individual plants of an unselected field correspond to the differences between selected varieties. Each plant of an unselected field might be said to represent a different variety, for it is generally possible by selection to establish a variety on the basis of the peculiarities of any individual plant. Selection is to be thought of as a process of narrowing the lines of descent, and thus securing a greater resemblance among the progeny. A seed produced by self-fertilization may be said to have only one parent, much as with plants propagated from cuttings.

Even the first generation of the progeny of a selected cotton plant may show a notable resemblance to the parent, for a large proportion of the seeds of the cotton plant usually represent the results of self-fertilization by the pollen of the same plant. Some of the plants must have descended from several generations of self-fertilized ancestors, and are thus in the same condition of breeding as though they had received the most careful selection. If the progeny are not uniform at first, they are likely to become so in a few generations of careful breeding. The growing of the offspring of single plants by themselves also keeps them from being cross-fertilized by pollen from other cotton.

If selection proves successful the result is to establish the expression of the characters of the original selected plant in all of its progeny, so that all the individuals of the stock shall show only the one set of characters instead of the characters of the whole miscellaneous group from which the original plant was selected.

DETERIORATION OF VARIETIES WITHOUT CROSSING.

The general result that is secured through selection is to keep the characters of the inferior ancestors from coming into expression, but selection does not seem to have any power to completely destroy the characters of the inferior ancestors so as to prevent their continued transmission for any number of generations and their subsequent reappearance in individual variations. The work of the breeder is never completely finished or absolutely successful. Though very high degrees of uniformity are attained by careful breeders, such uniformity is not a permanent condition. It has always to be preserved by further selection.

Even in the most carefully selected varieties of our domesticated plants and animals, where no crossing with other lines of descent has been allowed for many generations, individual variations away from the type continue to appear. With cotton grown under ordinary field conditions it is generally impossible to determine whether any particular variation has resulted from a crossing of varieties or from a spontaneous mutative variation without any recent crossing. Cotton pollen is carried by bees, and bees have been known to forage for honey at least two miles from their nests. But for practical purposes it makes little or no difference whether an inferior variation has been due to previous crossing or to some other cause. Experiments with cotton have shown that a change to new conditions, or even an unfavorable season, may call forth an unusual amount of individual variation in a previously uniform variety of cotton. New variations aroused in this way are very likely to come true to seed, so that the seed of the same stock appears pure in one place and impure in another.[a]

Each new variation constitutes, in effect, a new variety. The subsequent crossing of the different variations with each other and with the parent type produces hybrids just as if the variety had never been pure or as if it had been mixed with seed of other varieties by intention or by accident.

The farmer must understand, therefore, that even if he should succeed in keeping a new stock of cotton completely isolated from all other kinds it would still be liable to deteriorate as the result of spontaneous changes of characters or changes aroused by differences of external conditions. If selection be neglected long enough, even the most superior variety can deteriorate into an inferior mixture of varieties, like an unselected stock. This return to diversity is what is usually meant by the "running out" of a variety of cotton.

WHY SELECTION MUST BE MAINTAINED.

There is no known method or alternative by which the farmer can avoid the necessity of selecting his own cotton unless it be that of buying from neighbors who may be more willing to take the necessary trouble.

All that breeders and seed growers have said of the importance of obtaining pure strains of our varieties of cultivated plants may be admitted, but it also appears that even the purest strains can not be expected to stay pure unless selection is maintained. Now and then an individual plant will depart from the characters of the variety and show a tendency to small bolls or some other undesirable feature. It is important that all such plants be recognized as early in the season as possible and removed from the field.

Even if the farmer is skillful enough to detect all inferior plants at the end of the season and rejects their seed, he can have no assurance that the degenerate tendency has been removed. It is to be expected that insects have already infected other plants with the pollen of the degenerate individuals, and the undesirable characteristics may therefore be expected to reappear, even in the progeny of the best plants.

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[a] Local Adjustment of Cotton Varieties, Bulletin 159, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1909.

The next generation may not show the undesirable character, but this does not prove that it has been completely eliminated. Our present knowledge of the behavior of characters in hybrids indicates that the grandchildren and later descendants of a degenerate individual are more likely to show the degenerate characters than the immediate offspring. Thus, in spite of all the care that may be taken to reject the seed of every plant that brings undesirable characters into expression, degenerate characters may continue to be inherited for any number of generations.

Selection as applied to an improved variety of cotton is simply a means of keeping undesirable characters out of expression. One of the principal objects to be gained by detailed study of heredity in cotton is to learn the method of selection that keeps the undesirable characters most thoroughly suppressed.

VALUE OF EXTERNAL CHARACTERS IN SELECTING COTTON.

By using external characters in selection it is possible to secure a large measure of protection against the inheritance and subsequent expression of the characters of degenerate individuals. Studies of degenerate variations of several different types of cotton have shown changes in the external or vegetative characters as well as in those of the fruit and seed. It seldom, if ever, happens that a cotton plant makes a definite change in a single character and continues to resemble the parent variety in all other respects. Plants that are going to produce bolls, or seeds, or lint different from those of the parent variety usually give notice well in advance by changes in the external vegetative characters. Some of the most injurious variations are the easiest to throw out early in the season, if attention be given to the external characters. Peculiarities of individual plants that may appear to have no importance in themselves become very significant for purposes of selection.

Farmers who know their varieties well enough can detect and weed out degenerate variations in the seed plat even before the plants reach the flowering stage, and hence before they can contaminate the other plants with inferior pollen. It is much easier to recognize and reject degenerate plants on the basis of their external differences early in the season than after the crop has matured. The general characteristics of the young growing plants are much easier to see than the differences that have to be detected by examining the seed and combing out the lint.

Plants that are too degenerate to blossom or produce any seed are not dangerous to the remainder of the variety, but most of the bad plants produce flowers, even if they do not ripen seed. One of the worst forms of degeneracy in cotton, and one that seems to be very common in the eastern part of the cotton belt, is a more or less complete loss of lint. There are many degrees and stages of the bald-seeded condition down to completely naked seeds with not a vestige of fiber, either of fuzz or of lint. Naked seeds usually fall out on the ground and germinate as soon as the bolls open, but the tendency to produce the "slick" seeds can continue to be transmitted through the pollen, unless farmers learn to pull such plants out before they have flowered. Naked-seeded plants represent not only a present loss but a reduction of all future crops raised from the seed of fields in which they have been allowed to remain.

Completely naked seeds are rare, but seeds with no fuzz and very sparse lint are very common and are usually accompanied by distinct external differences in the plants that bear them. Many farmers who would not allow weeds to grow in their fields harbor thousands of degenerate cotton plants, each of which is likely to do much more harm than a weed could possibly do. Every seed that is formed as a result of crossing by the pollen of a degenerate plant represents one of the offspring of the degenerate plant quite as truly as do its own seeds.

HOW TO BECOME ACQUAINTED WITH A VARIETY.

Many farmers who have become quite skillful in detecting differences in the lint and seed characters of cotton pay very little attention to the plants themselves. They are in the condition of the general public that recognizes differences between fruits of different varieties of apples, but lacks the skill of the apple grower who sees even more differences between the various kinds of trees than between the apples they produce. Doubtless there are many people who can not learn to appreciate such differences, but most of those who are willing to use a little time in training their eyes are surprised to find that they can readily distinguish differences that they have previously overlooked entirely. The different kinds of cotton plants will cease to look all alike and stand out as distinctly as different breeds of poultry or other domestic animals. The differences of color that often help to distinguish breeds of chickens are lacking, of course, in the cotton, but it would not require a very skillful fancier to tell a white cochin from a white leghorn or a white plymouth rock.

The technical terms and elaborate measurements that are often used in the scientific study of variations are calculated to give the idea that it is a difficult matter to recognize the variations of plants in the field. In reality it is not so difficult as to recognize differences between individuals of the same variety of sheep or poultry, and this most farmers do. The making of scientific descriptions and measurements of variations is an entirely different problem from that of recognizing them in the field.

It is customary for breeders and seed growers to publish descriptions and pictures of their varieties, but the farmer should not expect to gain an adequate acquaintance with a variety from such sources. It is hardly possible to describe the differences between closely related varieties of such a plant as cotton so that they can be seen at once without skill and practice in observation. Indeed, many skillful breeders do not themselves know what the differences are that they use in selection, and are inclined to imagine themselves possessed of some special sense instead of a refinement of ordinary eyesight.

Even a photograph of a plant is of relatively little value as a guide or standard in the selection of cotton, for the plants of the same variety differ greatly in different places and different seasons. The familiarity that is needed for purposes of making selections has to be gained in the field where the selection is to be carried on. Selection is a matter of skill as well as of knowledge. The farmer must be willing to give himself a little training in the field and not expect to become fully qualified by anything he can read in a book.

The more familiar with a variety one becomes the more evident it will be that every field is likely to be different and may require to be judged by a different standard. The training of the eye so that it can carry the necessary standard is the secret of the art of selection. It is this that determines the farmer's ability to select his own cotton to the best advantage.

If the farmer doubts his own ability to acquire the necessary skill or is unwilling to take time to train himself, he may find that the wife or the children can give him valuable assistance. Women are often more expert than men in the matching of colors and qualities of fabrics, and children often have more acute powers of perception. European growers of seeds of high-grade varieties of flowers and vegetables claim that women and children are more skillful than men in cases that require extremely fine discrimination. If the necessary talents of good eyesight and keen discrimination should prove to be rare, there would be the greater reason for calling attention to the need of having them utilized by their fortunate possessors.

ESTABLISHING A STANDARD OF SELECTION.

One of the best methods of establishing or readjusting standards of selection for a variety of cotton is to begin by a study of the behavior of the best plants that can be found in the field. If there is doubt about the kind of plant that ought to be considered as representing the variety, it is well to look about for uniform groups of good plants. To see several good plants standing together in a row gives a more definite and useful impression of a standard that can be used in that particular field than can be secured by the study of scattered individuals. The work of selection is largely a matter of comparing a plant with its neighbors in the same field instead of with any arbitrary standard brought in from the outside.

With a plant as variable as the cotton and grown under such a vast range of differing conditions of climate and soil, it is worse than useless to rely upon any particular feature as an absolutely fixed requirement in selection. The Triumph cotton, for example, often has a characteristic shortening or semicluster condition of a few of the fruiting branches at the base of the plant. As the variety is bred by Mr. Alexander Mebane, at Lockhart, Tex., shortened lower branches are shown with remarkable uniformity over many acres. In other localities, and especially under conditions of more luxuriant growth, the peculiar habit of growth of the Triumph cotton may disappear more or less completely, so that whole fields may be found with no plants that would correspond to a standard carried over from Lockhart.

Any peculiar character, like that of the method of branching of the Triumph cotton, though it may have no direct economic importance in itself, may be very useful as a mark for distinguishing genuine examples of a variety. Yet it is doubtful whether any such character can always be trusted to appear under all conditions. Even a completely clustered variety like the McCall cotton produced no cluster plants in an experiment made in Guatemala a few years ago.

The need of selection does not appear to be the same every year, for the number of degenerate variations differs in different seasons as well as in different localities. Fields of a carefully selected variety grown under continuously favorable conditions that enable the plants to develop without being checked are sometimes extremely uniform. Each plant appears to be an exact counterpart of its neighbor. Yet in the most uniform fields an occasional individual may show pronounced differences. It is worth while, therefore, to go over the whole seed plat every year, even though a general inspection may give an idea that the plants are uniform. In another place or in a less favorable season the same stock may show many pronounced variations and may then degenerate very rapidly unless the diverse forms are removed.

SELECTION BY CHARACTERS OF STALKS AND LEAVES.

Young plants of a well-selected, uniform variety growing under the same conditions follow very closely the same course of development. They have the same kind of leaves; the joints of the stalks are of the same length and the branches develop at about the same rate and at the same height above the ground. A definite difference in any of these features is warrant for suspecting a plant and giving it closer examination. Another useful mark of distinction may be found in the hairs of the leaves or those of the leaf stems and the branches. A difference in the habit of growth or in the length of the joints is very likely to be accompanied by a difference in the amount of hairiness.

A study of the characters of small-bolled and other inferior plants that are very common in unselected cotton fields will aid the farmer in training himself to recognize some degenerate plants in their younger stages. When the necessary skill has been acquired it is almost as easy to see and pull out the inferior plants as it would be to give this treatment to the same number of weeds that might have sprung up in the row. In the great majority of cases it is not necessary to get close to the plant or give it any very detailed examination. Indeed, it is often better to stand at a little distance, so as to gain a general impression of a plant in comparison with its neighbors, than to begin with a closer and more detailed inspection. The general view of a plant as a whole often gives a more vivid impression of the fact that it is different from its neighbors than can be gained by more detailed comparisons of the different parts. The general view sums up, as it were, the more detailed differences of leaves, stems, and branches and the effects that such differences have in altering the appearance of the plant.

The habits of branching have a very direct relation to the earliness of the crop. Earliness becomes an especially important factor under boll-weevil conditions and should always be taken into account in selection. The main stalk of the cotton plant puts out two different kinds of branches. From the base of the stalk come the vegetative branches, or "wood-limbs," and above these the true fruiting branches that bear the bolls. The vegetative branches do not bear any bolls of their own, but put forth fruiting branches like those of the main stem, though shorter and of later development. Plants that grow too rank and produce too many of the vegetative branches can not begin to put on their crop as soon as smaller plants that produce fruiting branches closer to the ground. Small plants often ripen more bolls than their larger neighbors, especially under boll-weevil conditions. Even for cultural reasons it would be good policy to pull out any unusually tall, rank-growing plants that do not begin to bear early in the season, if only to give better conditions for neighboring plants that have begun to set their crop.

SELECTION BY BOLL CHARACTERS.

If the farmer is engaged in the selection of a big-boll variety of upland cotton, such as the Triumph, most of the degenerate plants are very easy to recognize, because they have small bolls. This fact becomes most apparent in unselected fields about the middle of the season, soon after the earlier bolls have reached full size, but before they begin to open. A little search will show that some of the plants are producing only small bolls. Some small bolls can be found, of course, on normal large-bolled plants, just as small or defective apples can be found on a large-fruited tree. Plants that appear in a big-boll variety but produce only small bolls no longer represent the variety, but are to be looked upon as definite variations away from the variety. They are like the inferior seedlings that may grow from the seeds of any large-fruited variety of apples or pears. The cotton plant differs from the apple tree in that the superior varieties usually come true to seed. The plants that depart from the characters of the parent variety are mostly very inferior, but even if they are not inferior they ought to be taken out of the variety to avoid a further increase of diversity through the formation of hybrids.

The differences in the size of the bolls and the importance of this character in selection are greater in the big-boll varieties than in those that normally have small bolls. Present indications all point to a rapid extension of the Texas big-boll types to other parts of the cotton belt. Big-boll varieties have a distinct advantage in diminishing the labor of picking, and their earliness and stormproof qualities are also important. It was at first supposed that the early, small-bolled cottons like King would have an advantage in weevil-infested regions, but the big-boll types are more popular than ever in Texas and are being extended rapidly northward and eastward.

The shapes, colors, and surfaces of the bolls also afford differences, of very little importance in themselves but very useful as indicators in selection to maintain uniformity. Indeed, it is possible in a great majority of cases to judge the quality of the lint correctly in advance by looking at the bolls of a plant, after one is sufficiently familiar with the variety. Plants with shorter bolls are likely to have shorter lint, while narrower bolls indicate less abundant lint. Any pronounced difference in the shape of the bolls can be taken to indicate that the plant is a variation or a hybrid that ought to be removed, and the same is true of differences in the color or in the character of the surface of the bolls. Some varieties have the bolls very pale, dull green, others deep green and shining. Some have the oil glands numerous and close together, while others have them few and scattering or confined to particular areas. Some have the oil glands distinctly marked as black dots on the surface of the bolls or set in distinct pits, while others have the oil glands deeply buried in the tissues, so that the surface of the boll is even and smooth. After the boll characters of a variety have been well learned, variations in any of these respects are readily appreciated.

Selection by boll characters is not as effective as selection by leaf and stem characters, because the inferior plants have already flowered and there has been an opportunity for their pollen to be spread about the field. Nevertheless, if the boll selection be made early enough much of the spreading of pollen in the latter part of the season can be avoided. The bees and other insects that carry the pollen usually become more numerous late in the season, and much more crossing probably takes place. Another advantage of boll selection is the opportunity that it gives to become better acquainted with the leaf and stem characters of degenerate plants and better ability to detect such plants early in the season in following years. If selection is deferred till the crop is ripe the external differences of the plants will have become much less apparent.

SELECTION BY SEED AND LINT CHARACTERS.

More time is required for the last selection, in which attention is given to the fertility of the plants and to the characters of the lint and seed. The labor will have been greatly lessened by the previous roguing out of all the plants that gave external evidence of tendencies to depart from the uniform type of the variety either in the habits of growth, in the characters of the leaves, or in the size and shape of the bolls. Plants that show themselves deficient in fertility or in earliness in comparison with their neighbors can also be omitted from the last selection. The examination of the lint is thus narrowed down to the plants that have appeared satisfactory in all other respects.

Preliminary study and comparison are necessary to enable one to judge the plants readily with respect to the length, strength, and abundance of lint, just as in the case of the external vegetative characters. Many planters have made a practice of noticing differences in lint and are already well qualified to perform this kind of selection.

The length and abundance of the lint are compared in the field by the familiar process of straightening it out from the sides of the seed, either by pulling between the thumb and finger or by using a small comb. One or more samples of the combed-out lint from different plants can be held between the fingers of the left hand and thus carried along for ready comparison. The strength of the lint is judged in the field by breaking the combed-out strands while held between the thumbs and first fingers of the two hands. Any plant is rejected that shows itself distinctly inferior to its neighbors in length, strength, or abundance.

SELECTION BY FLOWER CHARACTERS IN EGYPTIAN COTTON.

Egyptian cotton has one advantage over Upland cotton in the matter of selection, since the characters of the flower can also be made to assist in detecting the undesirable plants. Instead of being creamy white, as in Upland cotton, the Egyptian flowers are yellow and the petals have large purple spots inside, at the base of the petals. The petal spots are lacking on nearly all varieties of Upland cotton, but occur occasionally in some of the eastern small-bolled types, such as King. Egyptian plants with pale yellow petals or pale purple spots are very likely to have small bolls and short lint, and should be rogued out as soon as they can be recognized.

A careful grower of Egyptian cotton, willing to take all possible precautions to guard the purity and uniformity of his stock, could make four selections corresponding to the four different kinds of characters that enable him to detect inferior variations. Young plants, before the age of flowering, can be selected by the characters of their leaves, stalks, and habits of growth. When flowering begins the field can be gone over to throw out the pale-flowered individuals. After the bolls begin to reach full size, small-bolled plants may be rejected. When the crop is mature a judgment can be made of the fertility of the plants and of the characters of the lint and seed. With Upland cotton the absence of color differences in the flowers leaves only three selections to be made, though it is not impossible that degenerate plants may also be distinguishable by floral differences. Plants of Egyptian cotton that have small bolls are likely to have small flowers, and it may be that this will prove to be the case in Upland cotton also. If other varieties have been allowed to cross with the King cotton, the hybrids are likely to show the purple spots on the bases of the petals.

PICKING OF SELECTED SEED.

The picking of the seed of select plants can be managed in a variety of ways. The plants can be marked with tags or by tying on little strips of cloth near the top of the main stalk. Stripping the leaves off the stalk near the top is another way to mark select plants. Marks on the ground made by drawing the foot out from the base of each select plant may suffice if pickers of the select seed are to follow closely after the man who does the selecting, but should not be trusted if there is to be any delay. A few exceptional plants desired for individual selections can be specially marked with different tags or with cloth of a different color, or they can be picked by the selector himself into separate bags, thus avoiding all possible danger of mistake by other pickers.

Sometimes it is desirable to separate a field that is being picked for seed purposes into three groups or grades. Plants of the first grade can be marked as above to be picked first. The second group of plants that do not depart from the type but are not of especial excellence or fertility can be left unmarked, while undesirable plants that are not to be used for seed can have the top of the stalk broken down, to indicate that they are not to be picked until after the others.

The final selection and picking of the seed ought not to be deferred too long. If the work be put off till all the plants have ripened their crop, it becomes impossible to tell which are the early individuals that ought to be specially favored in selection. The last picking of seed, even from good plants, is often inferior, for many of the later bolls are likely to open prematurely as a result of drought or of frost. It is well, therefore, to have the seed plat large enough to supply the desired quantity of seed without waiting for the last picking, and to allow this to be thrown in with the general crop.

RAISING SELECTED SEED FOR SALE.

Farmers who acquire the necessary skill in selection and are consequently able to raise a uniform crop will often secure an additional advantage by selling seed to their neighbors. Many intelligent farmers who wish to obtain an improved variety of cotton will prefer to buy seed enough to plant a large field or to stock the whole farm at once and thus save themselves the extra trouble and loss of time required in beginning with a peck or a bushel. The same pains, or even greater, have to be taken to keep a small quantity of cotton from becoming mixed, either in the fields or at the gin, than for a large quantity. To bring a large quantity of a new and untried variety from a distance might be quite unwise and is a very different matter from adopting a variety that is behaving in a uniform manner in the same locality.

Local communities will profit in several ways by the presence of careful growers of selected seed. The seed that has been raised and selected in the same community is likely to give better results than any stock of the same variety that could be brought in from distant localities. Farmers who expect to sell their seed in their own community are likely to be much more careful to maintain the uniformity of the stock than those who expect to ship their seed to nonresident seed dealers.

A variety that can be obtained in quantity from a local grower is also more likely to be adopted by a whole community, which is another distinct advantage. The product of the community as a whole becomes more uniform and secures a better standing in the market. With one variety grown and carefully selected by a whole community, the difficulties of protecting the cotton from admixture at the gin or from cross-fertilization by bees in the field are greatly diminished.

The farmer who has learned how to maintain uniformity in his seed plat effectively has only to extend his method over his whole farm if he wishes to produce high-grade seed. No matter how uniform the variety may have been in the seed plat or in the fields in the preceding year, attention should still be given to the removal of any degenerate plants that appear. A new or unfavorable piece of ground or a bad season may bring out an unusually large number of degenerate individuals, and if these are allowed to remain in the field and cross-fertilize with the good plants the whole stock may be seriously injured. A single season's neglect may destroy the benefits of many years of careful work.

USE OF PROGENY ROWS IN SELECTION.

Selection of a high-grade variety of cotton can be somewhat simplified and also rendered more effective if the farmer is willing to take the additional precaution of saving the seed of each select plant separately in order to plant a part of it in a separate row the following season. It is very easy to buy a few cheap paper bags from the grocer, and the seed may be kept in these till the time of planting comes.

A slight amount of extra labor is also required to plant the progeny rows by hand. The number of seeds obtained from an average plant of upland cotton is not large, and it is desirable to hold as many of them in reserve as possible. The rows have also to be numbered or otherwise marked to identify them with the parent plants and the seed that is held in reserve.

If there are no facilities for the separate ginning of the small quantities of seed that come from individual plants, the seed can be planted without ginning. Mr. E. B. Boykin, who has carried on a large series of such experiments in South Carolina, reports that seed planted with the lint germinates as readily as with the lint removed, but this method is not advised for dry regions, where even the fuzz of the seed may interfere with germination. Smooth-seeded varieties have been found to germinate better than those with fuzzy seeds when planted in dry ground in Texas. In Texas and other dry regions there would undoubtedly be a demand for very small gins that would clean individual lots of seed without mixing. Machines of this kind could be of very simple construction and need not cost more than a few dollars. Such an invention would be of much benefit to the cotton industry even if it did not yield very large profits to the manufacturer. Rows of cotton raised in this way from the seed of individual plants of the same stock may show very distinct differences in vigor, productiveness, and uniformity. The comparison of whole rows instead of individual plants is an easier and more effective method of selection. If one row compares unfavorably with the next, the whole of the inferior row may be rejected without going over the individual plants in detail. The selection is more effective because all the individuals of a bad progeny can be rejected, whereas some of them that happened to be favorably situated might be saved in a mixed planting.

The use of the progeny rows enables an additional precaution to be taken to guard the purity of a good stock by holding over a part of the seed from which each of the progeny rows has been planted. If any of the rows should prove to be of exceptional merit it is possible to go back to the reserved seed of the parent of the best row and sow it in a separate isolated plat in the next season as the foundation of a special strain descended from a single superior plant.

Planters of Sea Island cotton are accustomed to the plan of narrowing their selection down to a single superior plant. They multiply the seed from this plant for two or three years in separate seed plats to secure enough for field planting. The very high quality and unusual uniformity of the Sea Island cotton are to be ascribed largely to the method of selection that has been followed.

The location of plantations on islands where no Upland varieties are grown and where consequently the bees could not cross-fertilize the Sea Island cotton with Upland pollen has undoubtedly assisted in maintaining uniformity. Planters of Upland cotton might secure the same advantage if whole communities would organize and agree to plant only one kind of cotton. This is especially necessary in districts where long-staple varieties are grown and the uniformity of the lint directly determines its market value.

The use of progeny rows in no way avoids the necessity of thorough familiarity with the variety that is being selected. Unless the breeder is skillful enough to limit his selection to one type of plant, mixture can occur in progeny rows as well as in general plantings. Only one type of plant should be grown in the same seed plat, whether planted in progeny rows or not. It is just as important to rogue out degenerate plants from progeny rows as from any other plats or fields where selection is being maintained. However skillful the selection that may be given at the end of the season, its value is already diminished if the select plants have been cross-fertilized by the pollen of degenerate neighbors. It is plain from the results that have been obtained that a farmer who knows his type well enough can maintain a more uniform stock by general field selection without progeny rows than a careless breeder with progeny rows.

Planting different varieties side by side is a good method of learning their differences or testing their yields, but seed should not be saved from such mixed plantings with any idea of further breeding unless the object is to experiment with hybrids. The danger of cross-fertilization forbids any close combination of the work of breeding with that of testing varieties. A seed plat consisting of progeny rows of the same type of cotton may be looked upon as a test of the vigor and fertility of the different lines of descent inside the variety, but this is not the same as testing different varieties. And even in dealing with progeny rows of one type the best results are to be expected by going back to the seed that remains from the parent of the best row and planting it under conditions of as complete isolation as possible. This system requires an increase plat for multiplying the seed of the best selection in addition to the breeding plat where select progenies are grown side by side for comparison.

The need of reserving a part of the seed of each of the parent plants until a progeny row has been grown is rendered especially necessary if the conditions do not provide complete isolation from other varieties. If crosses with other strains or varieties are taking place, much of the work with the progeny rows may be wasted.

The greater vigor and fertility of plants that result from cross-pollination may give such plants an apparent superiority and induce the breeder to select them as parents of progenies. The next generation is likely to show diversity and allow the hybrid nature of the parent to be detected, but perhaps not in time to protect the rest of the breeding plat from crossing with the pollen of the hybrids. The value of seed raised in progeny rows depends largely upon the degree of isolation that can be maintained, but some of the danger can undoubtedly be avoided if a part of the seed of the parent plants is held in reserve until the progeny rows have been compared.

The chief object to be gained by selection, whether applied to progeny rows or to individual plants, is to maintain the uniformity and productiveness of the variety. It is a serious mistake from the agricultural standpoint to suppose that selection is of no value because the variety does not continue to improve and become more and more excellent as a result of persistent selection. The old idea of selection as an active agency that could compel plants to change their characters in any desired direction is being given up. It is not to be assumed that varieties selected for many years are necessarily better than those of recent origin. New variations are often as uniform as the parent stock from the time of their first appearance. The present tendency is to believe that the value of selection as an agency of improvement lies chiefly, if not wholly, in the fact that it separates and preserves the good strains or lines of descent and throws out lines that tend to produce inferior individuals.

This kind of improvement may be considered as finished when a variety has become pure and uniform, so that it contains only one type of plant. Selection might stop if the purity and uniformity would continue without it, but the testing of different lines of descent, even in the best and purest varieties, always shows that there are differences among them. Even though they do not show any definite departure from the characters of the variety they are found to differ in vigor and fertility, so that the need of selection remains.

The tendency of recent investigations of such questions is to show more clearly that the chief effect of selection is to maintain varieties rather than to change them. Some investigators hold that no further improvement is to be expected after a pure, uniform type has been obtained, but it is no less important to preserve such a type than to select it in the first place.

BREEDING NEW VARIETIES OF COTTON.

The preceding discussion of selection relates to the work of maintaining the uniformity of desirable varieties rather than to the origination of new varieties. It is true, of course, that every special selection of cotton may be considered as somewhat different from every other selection, and seed dealers have a custom of giving many new names to slightly different strains of old varieties or even to strains that do not show any appreciable differences.

Any farmer who learns how to select the variety of cotton that he is already growing will find it extremely easy to breed new varieties if he wishes to take the trouble. Any plant that varies distinctly from the characters of its parent stock is likely to give rise to a new variety. Most of the degenerate plants that have to be pulled out and thrown away might be made into a new variety. The difficulty is not to get new varieties; the trouble is that most of the variations are degenerate, in the sense that they are inferior to the parent stock for agricultural purposes.

For those who can learn to distinguish the types and carry on the selection, the chief practical difficulty in the work of breeding new varieties is that of isolation; that is, of keeping the different varieties from crossing with each other and with the parent stock. The danger is that the farmer who desires to originate new varieties will turn his seed plat or his progeny rows into a collection of different sorts instead of maintaining a pure culture of one kind of cotton. The mixing of different types of cotton in progeny rows may be expected to have the same undesirable effects as mixing in the field.

If the farmer undertakes the breeding of new varieties there is the same reason for keeping them away from the regular seed plat as for keeping the seed plat away from other fields of cotton. Only one type or variety of cotton ought to be planted in any plat or field that is being grown for seed or for breeding purposes. The selection of peculiar plants for the purpose of obtaining new varieties is an entirely different line of work from the selection that has to be carried on in each variety to maintain the uniformity and productiveness of the type.

Unless the farmer is willing to become a regular breeding specialist and take the trouble of artificial hand pollination in order to secure pure seed of his new type, he had better confine his attention to his general farm variety or limit himself to a few special plants whose progeny can be grown in separate places, such as the flower or vegetable garden, or on other parts of the farm distant as far as possible from other kinds of cotton.

CONCLUSIONS.

The full possibilities of improving the cotton crop can not be realized until the work of selection is carried out on every farm and becomes established as a regular part of the care of the crop. The only adequate alternative is the purchase of selected seed from a careful neighbor who maintains his selection and produces a uniform crop.

One of the most important advantages of the plan of raising cotton for seed in a separate field or plat is that the farmer is likely to give the plants more attention and thus become more familiar with the characteristics of the variety that the plants represent. Such familiarity is necessary in order to qualify the farmer or the breeder to establish and maintain the uniformity of the variety by selection.

Though much of the undesirable diversity of the crop can be ascribed to the mixture of varieties, it is not possible to keep any variety uniform without continued selection. Spontaneous changes to inferior characters occur even in the most uniform varieties, and if such variations are not removed the uniformity of the stock is gradually destroyed.

A farmer who knows his variety well enough can make use of the external characters for the removal of inferior plants early in the season, when this work can be done more easily and efficiently than by waiting for the lint and seed characters at the end of the season.

Attention to the external characters makes it possible to detect degenerate plants, those that will produce small bolls and inferior lint, even before they have begun to flower. The roguing out of such plants early in the season guards the uniformity of the crop by preventing the cross-fertilization of good plants with pollen of inferior individuals.

The farmer should not hope to equip himself for the work of selection merely by reading a description or looking at a picture of a variety. He should begin with a reliable stock of seed of a desirable variety and should familiarize himself with the plants as they grow in the field.

The best method of establishing a standard of selection to be applied to any particular field, seed plat, or progeny row of cotton is to fix upon groups of the most uniform and otherwise desirable plants as representing the variety in that particular place.

The cotton plant is extremely susceptible to influences of soil and climate. Each variety shows a wide range of differences under different conditions, and the proportion of degenerate plants, those that make definite changes away from the characters of the variety, is also influenced by the conditions under which the plants grow.

In addition to larger and better crops, farmers who learn the art of selecting cotton can usually gain an advantage from the sale of seed in their own localities. Seed grown in a uniform field in the same locality is always to be preferred to seed from a distance. Even a uniform stock is likely to show numerous variations when grown for the first time under new conditions.

The breeding of new varieties of cotton is possible for any farmer who learns how to carry on the necessary work of selection, but should be recognized as an entirely different undertaking from the continued selection needed to maintain the uniformity of any existing variety. Only one variety should be admitted into the same field or seed plat.

It is not desirable to increase the number of varieties in any locality unless new types showing definite superiority can be obtained. Distinct agricultural and commercial advantages would be gained if each cotton-growing community would limit itself to a single variety.

The popular idea that persistent selection will bring about a continued improvement in a pure-bred variety is now questioned in the scientific world, but this does not affect the agricultural importance of selection as a means of preserving the uniformity and productiveness of varieties.

Approved:
JAMES WILSON,
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